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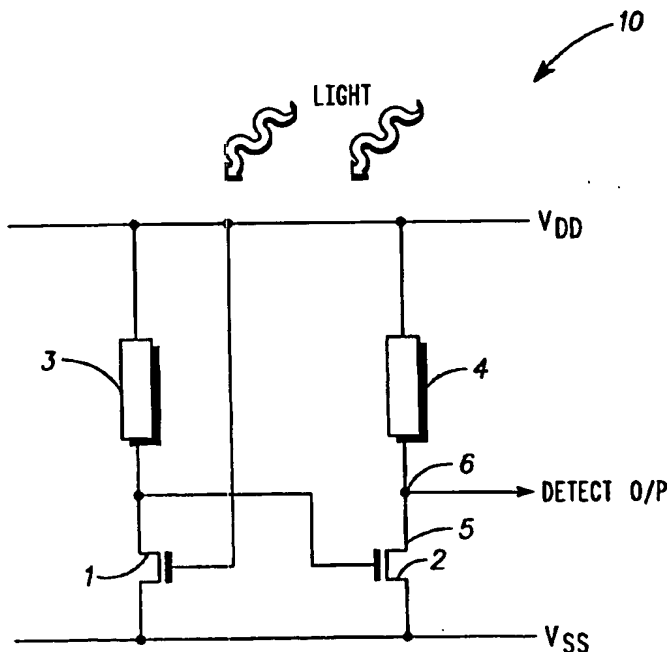
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/EP97/06168 (22) International Filing Date: 3 November 1997 (03.11.97) (30) Priority Data: 9624198.9 21 November 1996 (21.11.96) GB (71) Applicant (for all designated States except US): MOTOROLA LTD. [GB/GB]; Jays Close, Viables Industrial Estate, Basingstoke, Hampshire RG22 4PD (GB). (72) Inventors; and (75) Inventors/Applicants (for US only): WHELAN, John [GB/GB]; 33 Alwyn Drive, East Kilbride G74 4RL (GB). STOUT, Graham, Henry [GB/GB]; 44 Carrick Crescent, Giffnock, Glasgow G46 6PP (GB). (74) Agents: IBBOTSON, Harry et al.; Motorola, European Intellectual Property Operations, Midpoint, Alencon Link, Basingstoke, Hampshire RG21 7P1 (GB).		(81) Designated States: CN, JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: LIGHT DETECTION DEVICE

(57) Abstract

A light detection device has a biasing transistor (1) arranged to provide a bias current and a reverse biased transistor. The reverse biased transistor has a drain terminal (6) coupled via a high impedance resistor (4) to the supply voltage. Incident visible light is detected by a voltage drop at the drain electrode.



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## LIGHT DETECTION DEVICE

### Field of the Invention

- 5 This invention relates to light detection devices and particularly but not exclusively to light detection devices for use in tamper detection applications.

### Background of the Invention

10

In a semiconductor integrated circuit (IC), such as a banking smartcard, the IC is vulnerable to a breach of security if it falls into the hands of a dishonest person. The IC may be reverse engineered in order to reveal or modify functions and confidential data contained therein. It is known that  
15 such IC's have been decapsulated and have even undergone depassivation of the upper protective layer.

20

US patent 4,952,796 describes a circuit which comprises a current generator delivering current which flows into a reversed biased transistor junction. If subject to light, the reverse current in the junction increases, and the voltage at the junction terminals drops.

25

A problem with this arrangement is that incident light will generate reverse currents in transistors 11 and 2 of FIG.1, and this may affect the voltage drop detected at the output. Furthermore, the biasing and current generation functions of the above circuit are more susceptible to manufacturing process variations.

30

Also current drain, particularly in a smartcard, should be kept to a minimum, and the reverse current adversely affects the current consumption of the device. Lastly, the above circuit takes up much valuable semiconductor area, and again this is disadvantageous in a smartcard, where demand for space is at a premium.

35

This invention seeks to provide a light detection device which mitigates the above mentioned disadvantages.

### Summary of the Invention

According to the present invention there is provided a light detection device  
5 comprising: a biasing transistor, arranged to provide a bias current; a  
reverse biased transistor having a control electrode arranged to be reverse  
biased by the bias current and having a conducting electrode; and, a  
resistor coupled between a supply voltage and the conducting electrode of  
the reverse biased transistor; wherein incident visible light is detected by a  
10 voltage drop at the conducting electrode of the reverse biased transistor.

In this way a light detection device is provided which does not generate  
parasitic reverse currents, and is less susceptible to manufacturing  
process variations.  
15

### Brief Description of the Drawing(s)

An exemplary embodiment of the invention will now be described with  
20 reference to the single figure drawing which shows a preferred  
embodiment of a light detection device in accordance with the invention.

### Detailed Description of a Preferred Embodiment

25 Referring to the single figure drawing, there is shown a light detection  
device 10, arranged to be integrated with an IC.

The device 10 comprises a first transistor 1, having a gate terminal coupled  
30 to a supply voltage Vdd, a source terminal coupled to a ground terminal  
Vss and a drain terminal coupled to the supply voltage Vdd via a first high  
impedance resistor 3. The first transistor 1 is thus arranged to provide a  
bias current to be further described below.

35 A second transistor 2 of the device 10 has a gate terminal coupled to the  
drain terminal of the first transistor 1, a source terminal coupled to the  
ground terminal Vss and a drain terminal 5 coupled to the supply voltage

-3-

Vdd via a second high impedance resistor 4, and further coupled to an output terminal 6. The high impedance resistor 4 is an undoped polysilicon resistor.

- 5 In operation, the gate terminal of the second transistor 2 is arranged to be reverse biased by receiving the bias current from the drain terminal of the first transistor 1.

10 When the drain terminal 5 of the second transistor is subjected to incident visible light, a small reverse current is generated between drain 5 and the ground terminal Vss. This current flow lowers the voltage at drain 5, and this voltage drop is detected by circuitry (not shown) coupled to the output terminal 6.

- 15 Since the second high impedance resistor is an undoped polysilicon resistor, extremely small currents can be detected, making the device 10 very sensitive to incident light.

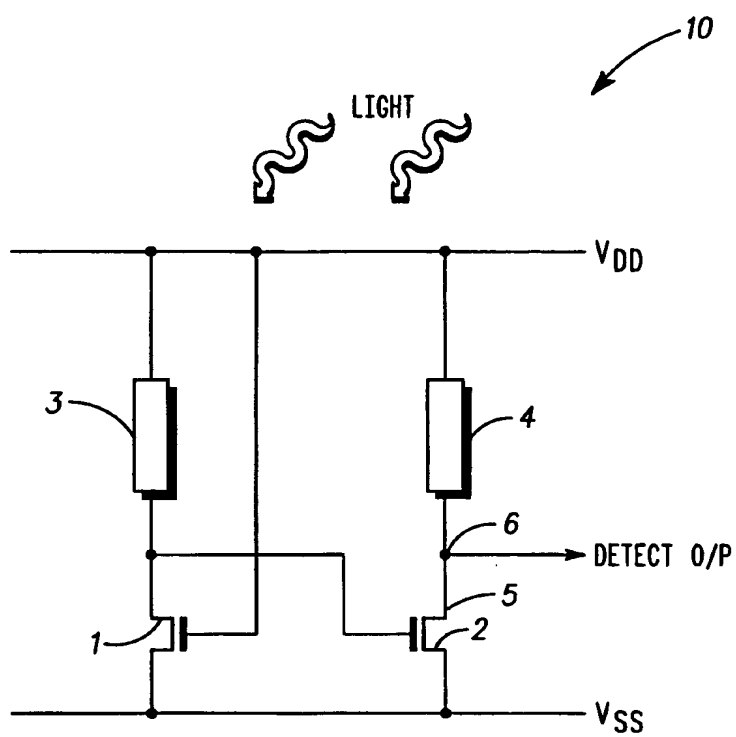
20 No parasitic reverse currents are generated, and during the manufacturing process of the device 10, only one resistivity process is required to fabricate the first and the second high impedance resistors 3 and 4, and this will not introduce variations which will significantly affect the performance of the device 10.

- 25 It will be appreciated that alternative embodiments to the one described above are possible. For example, the biasing arrangement may vary from the precise configuration described above. In addition, the first and second resistors could be fabricated from a material other than undoped polysilicon.

Claims

1. A light detection device comprising:  
5 a biasing circuit arranged to provide a bias current;  
a reverse biased transistor having a control electrode arranged to be reverse  
biased by the bias current and having a conducting electrode; and,  
a resistor coupled between a supply voltage and the conducting electrode of  
the reverse biased transistor;  
10 wherein incident visible light is detected by a voltage drop at the conducting  
electrode of the reverse biased transistor.
2. The device of claim 1 wherein the resistor is a high impedance  
resistor.  
15
3. The device of claim 1 wherein the resistor is an undoped polysilicon  
resistor.
4. The device of claim 1 wherein the biasing circuit comprises a biasing  
20 transistor having a conducting electrode coupled to the supply voltage via a  
biasing resistor.
5. The device of claim 4 wherein the biasing resistor is a high  
impedance resistor.  
25
6. The device of claim 5 wherein the biasing resistor is an undoped  
polysilicon resistor.
7. A smart-card incorporating the device of claim 1.

1 / 1

**FIG. 1**



## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 97/06168

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 G06K19/073 H01L27/144

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 G06K H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 952 796 A (FRUHAUF SERGE ET AL) 28 August 1990 cited in the application see abstract; figure 1 ---	1-7
A	GB 2 074 788 A (TOKYO SHIBAURA ELECTRIC CO) 4 November 1981 see abstract; figures 3,5 see page 1, line 38 - line 52 see page 2, line 3 - line 15 ---	1-6
A	US 4 910 707 A (SCHRENK HARTMUT) 20 March 1990 see figures 2,4 see column 3, line 23 - column 4, line 24 --- -/--	1-6



Further documents are listed in the continuation of box C.



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Date of the actual completion of the international search

14 April 1998

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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>EP 0 437 307 A (PARADIGM TECHNOLOGY INC)  17 July 1991  see abstract; figure 2  see column 2, line 2 - line 32  -----</p>	1-3

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Information on patent family members

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